

Review of Yerington Mine Characterization Activities

December 9, 2004

Report Prepared for:

United State Department of the Interior
Bureau of Land Management
Nevada State Office

Prepared by:

Technical Resources Group, Inc.
Idaho Falls, Idaho

Background

A site visit was conducted on December 9, 2004 to review current and ongoing site characterization activities at the Yerington Mine site. The site visit was conducted by Tom Olsen from the Bureau of Land Management (BLM) and Tom Clawson and Doug Walker from Technical Resources Group, Inc. (TRG). Historical operations at the Yerington Mine have been identified as having contributed to elevated radiation levels measured in and around the process areas. The measured increase in radiation levels resulted from natural radioactivity found in native ore and soil becoming concentrated in the waste streams during the copper recovery process. The elevated radiation levels have been identified as a potential concern for exposure to workers performing site characterization and remediation activities at the site.

To address radiological hazards during the site characterization phase, a Radiological Control Technician (RCT) has been hired by Atlantic Richfield Company (ARC). The RCT is responsible for performing radiation surveys and environmental monitoring to identify and characterize the radiological hazards in the process areas and to ensure that current activities are protective of workers and visitors as set forth in the health and safety plans. At the time of the site visit, the RCT had been located on the Yerington Mine Site for approximately one week.

The site visit included a review of the Yerington Mine operations and an overview of the RCT activities being conducted at the site for evaluating radiological hazards. Additionally, representatives from TRG performed an initial site-scoping survey for the BLM. This scoping survey consisted of performing a limited number of radiological survey measurements to determine the presence of elevated radiation and the collection of three grab samples of soil to be analyzed for specific radioisotopes of the uranium and thorium decay series.

Site Review and Observations

Access to the Yerington Mine and process area is currently restricted by an exterior fence and locked gate at the entrance. An administrative building, located at the mine entrance, serves as a central point for controlling access to the site. Brown and Caldwell, the primary contractor performing site characterization for ARC, is responsible for implementing and maintaining operations as outlined in the site health and safety plan. The Operations Manager for Brown and Caldwell provided a safety briefing to the BLM and TRG visitors.

Radiation survey measurements were performed around the surface area of Slot Pond 2 and throughout the process area. These preliminary measurements were performed using a calibrated Ludlum Model 2241-3 hand-held survey instrument, coupled with a 1x1 inch Sodium Iodide (NaI) scintillation detector, for a total measurement of direct radiation (gamma radiation exposure rates measured in units of microRoentgens ($\mu\text{R/h}$)). The NaI detector provided

increased sensitivity for scanning the general area to locate the presence of elevated concentrations of natural radioactivity in isolated or “hot-spot” locations. In areas where surface contamination surveys were performed, a calibrated Ludlum Model 2241-3 hand-held survey instrument, coupled with a Model 44-9 (pancake GM) detector was used and results were measured in counts per minute (cpm).

For general area surveys, radiation exposure rate measurements were recorded at waist level (approximately 3.3 ft). When elevated levels were observed on the instrument, an additional surface (on contact) level measurement was also performed and recorded along with the waist level value. Radiation exposure rates were recorded and logged with the corresponding measurement identification number and GPS location. A total of 22 radiation survey measurements were recorded and three “grab” soil samples were collected during the site visit.

Slot Pond #2

The radiation measurement and soil sample locations, GPS coordinates, and radiation survey results for Slot Pond 2 are presented in **Table 1**. As presented in **Table 1**, surface measurements were only performed at waist level since radiation levels appeared evenly distributed and no “hot spots” were identified in this area. No attempt was made at this time to measure the heap piles located behind the Slot Ponds. At the request of the BLM, a grab sample of soil was collected from the basin of Slot Pond 2. Sample location 7 was located near the basin pump where there appeared to be a build up of soil. No exposure rate measurement was made in the general area of where the sample was collected.

Results for radiation survey measurements performed around the Slot Pond 2 area are shown in **Figures 1-2**. As shown, these measurements did not identify radiation levels significantly above background levels for the area. The measured exposure rates ranged from 19 $\mu\text{R/h}$ to 24 $\mu\text{R/h}$ at locations 1-6 around the edge of Slot Pond 2. These measured levels appear to be consistent with measurements performed earlier by Foxfire Scientific, Inc. (Foxfire 2004).

Table 1 Summary of Survey and Soil Sample Locations, GPS Coordinates, and Exposure Rate Readings for Slot Pond 2.

Sample Location ID	GPS Location		Location Description	Radiation Exposure Rate	
	Latitude (N)	Longitude (W)		3.3 ft. Height (μR/h)	Surface ^a (μR/h)
1	38.99033	119.18650	Edge of Slot Pond 2	19	
2	38.99031	119.18671	Edge of Slot Pond 2	21	
3	38.99034	119.18718	Edge of Slot Pond 2	23	
4	38.99058	119.18724	Edge of Slot Pond 2	24	
5	39.99092	119.18717	Edge of Slot Pond 2	19	
6	38.99111	119.18655	Edge of Slot Pond 2	19	
7	38.99069	119.18659	Soil Sample at Basin of Pond 2	N/A ^b	

^a Surface measurements were performed at the sample locations when waist level values were significantly higher than background for the general area.

^b A waist level measurement was not collected from the basin of Slot Pond 2. A surface radiation measurement on the grab sample of soil showed no increase in radiation levels above background.

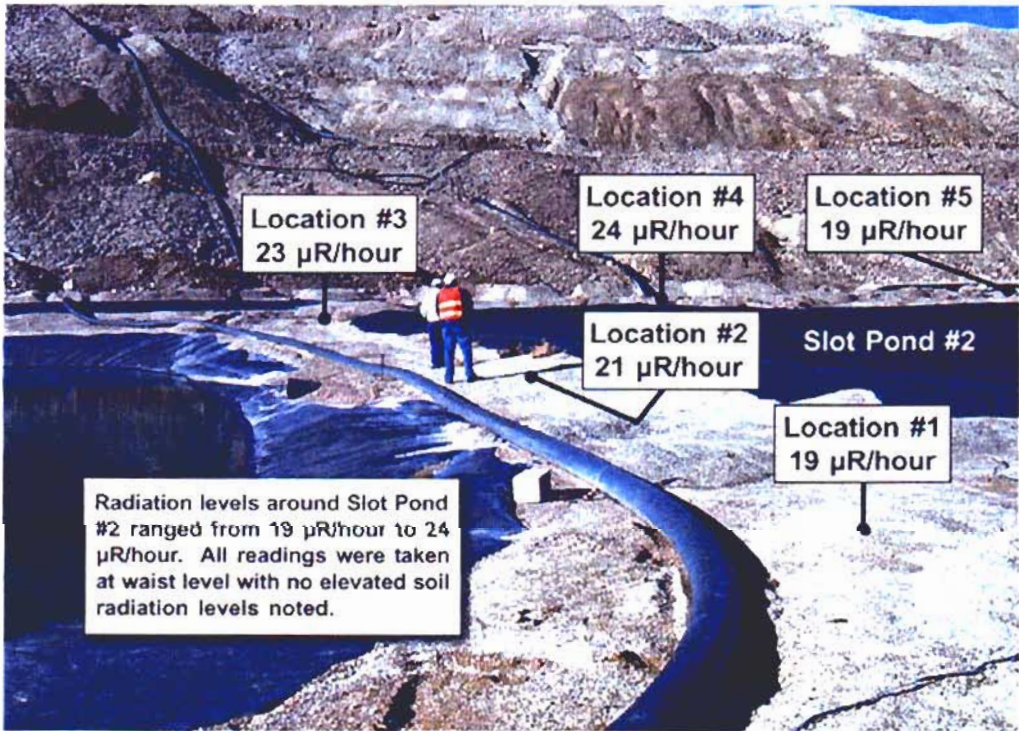


Figure 1 Radiation Survey Measurements Results Performed Around Slot Pond #2.

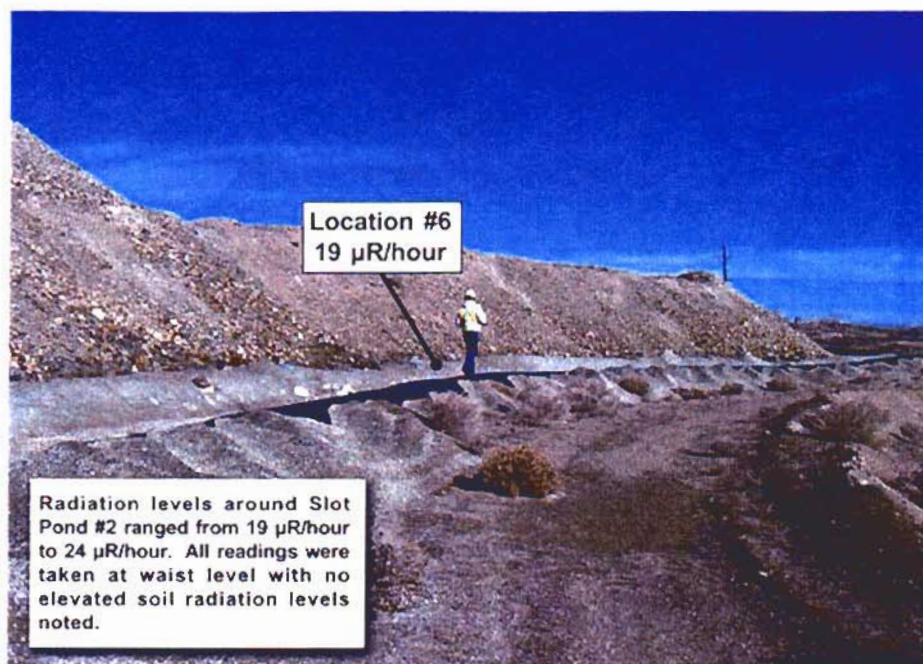


Figure 2 Survey Measurement Location 6 On North Side of Slot Pond #2.

As shown in **Figure 3**, an employee of Brown and Caldwell collected the soil sample for the BLM while performing routine maintenance on a basin pump. The soil texture of the sample appeared to be a mixture of sandy-like soil and fine gravel. A radiation survey measurement performed on the soil sample did not indicate levels above area background.

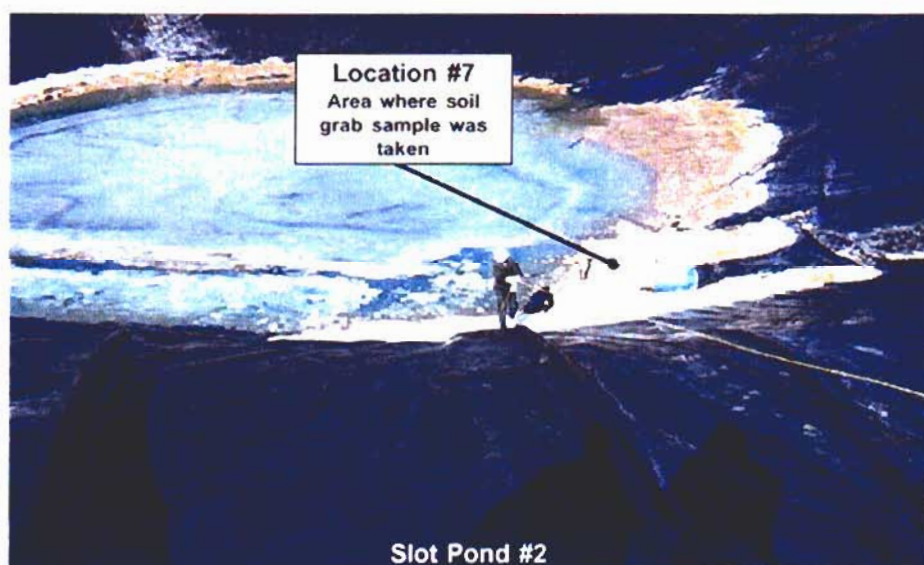


Figure 3 Location of Grab Sample of Soil Collected from Basin of Slot Pond #2.

Mine Process Area

The remainder of time during the site visit focused on the process area of the Yerington Site. As reported in previous assessments conducted for the BLM by Walker and Associates, the process area was identified as having higher concentrations of natural radioactivity in surface soils, and therefore an increased potential for exposure risk to workers. As a result of the previous study, and concerns about worker exposures, characterization activities currently conducted in the process area by Brown and Caldwell employees are being supervised by the RCT. When time permits, the RCT has been conducting radiation survey measurements around the process area to establish radiological control boundaries in accordance with the ARC health and safety plan.

Because the RCT has only been on site for approximately one week, a comprehensive radiation survey of the area has not been completed. However, during the BLM site visit, several radiation survey measurements were performed by TRG to develop an understanding of the source and distribution of elevated radiation levels in and around the process area.

Survey locations for radiation measurements conducted around the process area during the BLM site visit are shown in **Figure 4**. The measurement locations, GPS coordinates, and radiation survey results for the process area are presented in **Table 2**. Surveys were performed around the iron launders, solution tanks, and one location near the upper vat tanks. A more detailed description for each of these areas is presented in **Figures 5-12**.

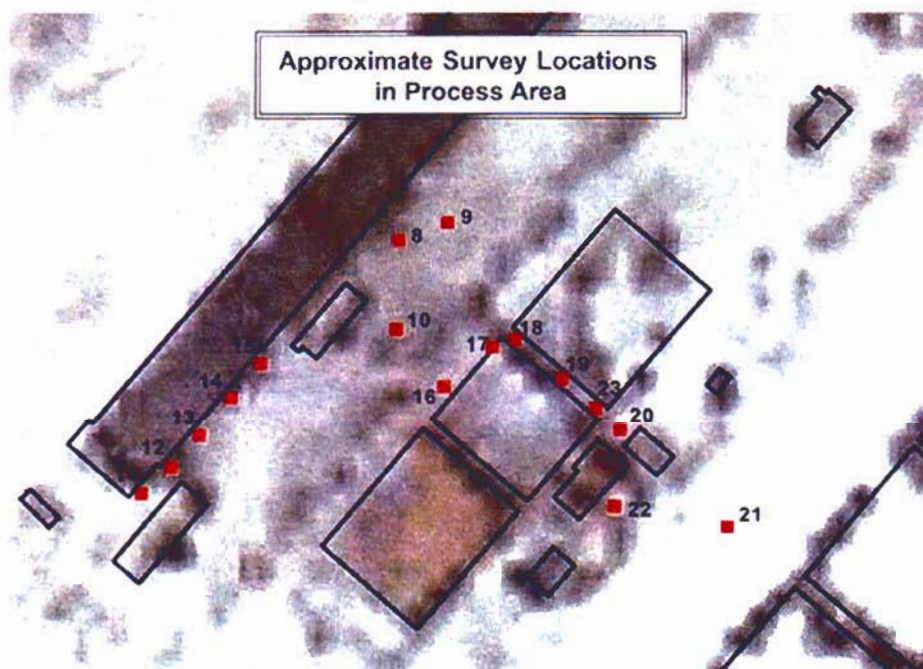


Figure 4 Radiation Survey Measurement Locations Around the Yerington Mine Process Area.

Table 2 Summary of Survey and Soil Sample Locations, GPS Coordinates, and Exposure Rate Measurements from Selected Locations Around the Process Area.

Sample Location ID	GPS Location		Location Description	Radiation Exposure Rate	
	Latitude (N)	Longitude (W)		3.3 ft. Height (μ R/h)	Surface ^a (μ R/h)
8	38.99762	119.20335	Trench near iron launders. Soil sample collected in this area	200	1,800
9	38.99749	119.20317	Surface soil near iron launders. Soil sample collected near stake	500	4,000
10	38.99758	119.20356	Surface reading with contamination probe		200,000 cpm ^b
11	38.99812	119.20399	Along iron launders between track and concrete wall	30	
12	38.99809	119.20392	Along iron launders between track and concrete wall	25	130
13	38.99807	119.20385	Along iron launders between track and concrete wall		230
14	38.99806	119.20385	Along iron launders between track and concrete wall		450
15	38.99799	119.2038	Along iron launders between track and concrete wall		226
16	38.99758	119.2039	Along roadway near concrete solution tanks	25	
17	38.99749	119.2038	Edge of concrete solution tanks	30	66
18	38.99723	119.20378	Walkway between solution tanks	31	
19	38.99714	119.20378	Southwest side of wooden walkway between solution tanks	115	1,000
20	38.99711	119.20389	Debris pile southwest of solution tank walkway		5,700
21	38.99692	119.20416	On roadway near upper vat tanks	20	
22	38.99712	119.20409	Red colored soil above solution tanks		90
23	38.99718	119.20383	General area exposure rate between location 19 and 20	40	

^a Surface measurements were performed at the sample locations when the waist level values were significantly higher than background for the general area.

^b A surface contamination survey was performed on the inside surface of the pipe, where there was build up of scale. The survey results were therefore reported in unit of counts per minute (cpm).

Radiation survey measurements conducted around the process area suggest that soil contamination (natural radioactivity, concentrated above normal background levels) has occurred over time from the copper extraction process. Survey locations 8-10 represent elevated radiation levels measured between the iron launders and solution tanks. As shown in **Figure 5**, there are several discrete soil locations that were previously identified and marked by the RCT as having elevated radiation levels.

Soil contamination in these areas also suggests that subsurface piping, trenches and structures connecting the iron launders to the solution tanks may have contained elevated concentrations of natural radioactivity and most likely contributed to contamination observed in surrounding soils. Survey measurements obtained from location 8 were from a trench containing piping, which at one time may have been connected to the solution tanks.

As shown in **Figure 6**, radiation exposure rates ranged from 80 $\mu\text{R/h}$ to 1,800- $\mu\text{R/h}$ (1.8 mR/h) on contact with the soil in the trench. The general area radiation levels measured approximately 200 $\mu\text{R/h}$ at waist level. Based on the elevated radiation levels in the trench area, a grab sample of soil was collected from this location. The soil was red in color, similar to the soil and sludge seen in the solution tanks and the waste pond area.

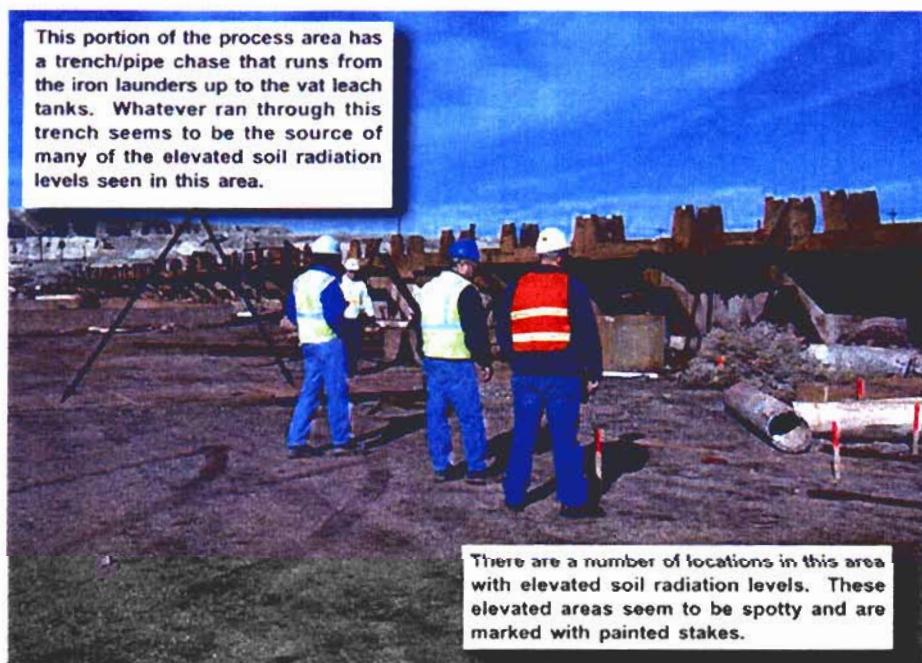


Figure 5 Locations Previously Identified in the Process Area as Containing Elevated Radiation Levels.

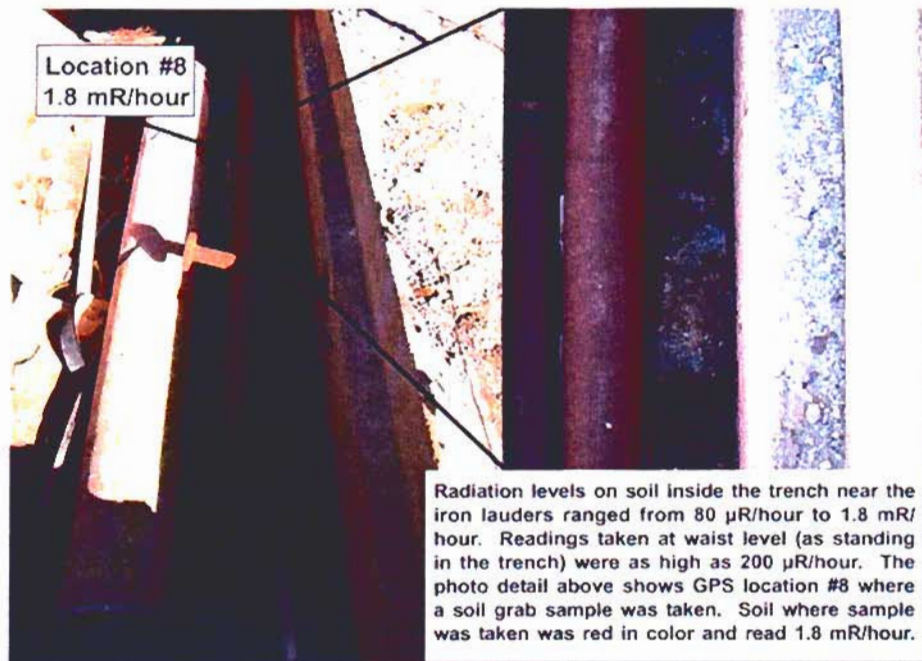


Figure 6 Service Trench Located Between the Iron Launderers and the Solution Ponds.



Figure 7 Measurement of Surface Soil with Elevated Radiation Level Near the Iron Launderers. Shown in the picture are the site RCT (in back) and a representative from TRG, Inc.

Survey measurements recorded for locations 9 and 10 are also near the iron launders. As shown in **Figure 7**, location 9 was previously flagged by the RCT and the immediate area was marked with a control barrier. The radiation exposure rates measured in this area were approximately 500 $\mu\text{R}/\text{h}$ at waist level, while reading 4,000 $\mu\text{R}/\text{h}$ (4 mR/h) on contact with the surface soil. A grab sample of surface soil was also collected from this location, near the post marker. Soil collected at this location was representative of other surface soils around the process area. There was no distinct discoloring to the soil like that collected in the trench area at location 8. A radiation survey measurement performed on the soil sample taken from this location yielded 2,000 $\mu\text{R}/\text{h}$ (2 mR/h)

Surveys were performed on a small section of pipe located in the process area, between the iron launder and the solution ponds. As shown in **Figure 8**, elevated radiation levels were identified as pipe scale on the interior surface of the piping. The pipe scale containing the concentrated radioactivity was primarily fixed contamination (not readily removable from the surface). The contamination count rate was recorded as 200,000 counts per minute (cpm) on contact with the surface and recorded as location 10.

Radiation survey measurements from locations 8 through 10 suggest that elevated concentrations of natural radioactivity are likely to be located in subsurface trenches and structures, surface soil areas, and piping. Preliminary surveys conducted during this site visit did not identify unacceptable radiation levels to personnel performing characterization work in the general area. However, there are discrete soil areas, and trenches in the process area that should be characterized and posted to minimize direct and prolonged contact by workers.

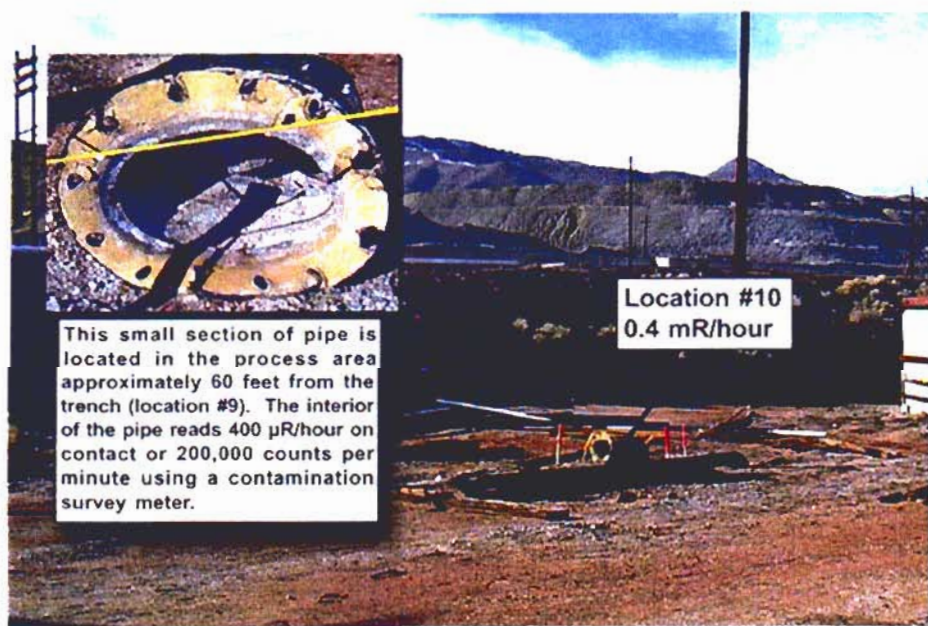


Figure 8 Survey Location 10, Small Section of Pipe Containing Fixed Contamination on the Interior Surface.

Survey locations 11-15 are located between the iron launders and rail track. The radiation exposure rates recorded in this area ranged from 25 $\mu\text{R}/\text{h}$ to 30 $\mu\text{R}/\text{h}$ level at waist level. The highest level recorded on contact with surface soil in this area was 450 $\mu\text{R}/\text{h}$. Radiation levels measured around this area were more uniform than previous measurements collected in the trench and surface soil areas. However, as shown in **Figure 9**, there is a large amount of structural and process debris that has weathered over time and now restricts access within this area for completing a thorough radiation survey.

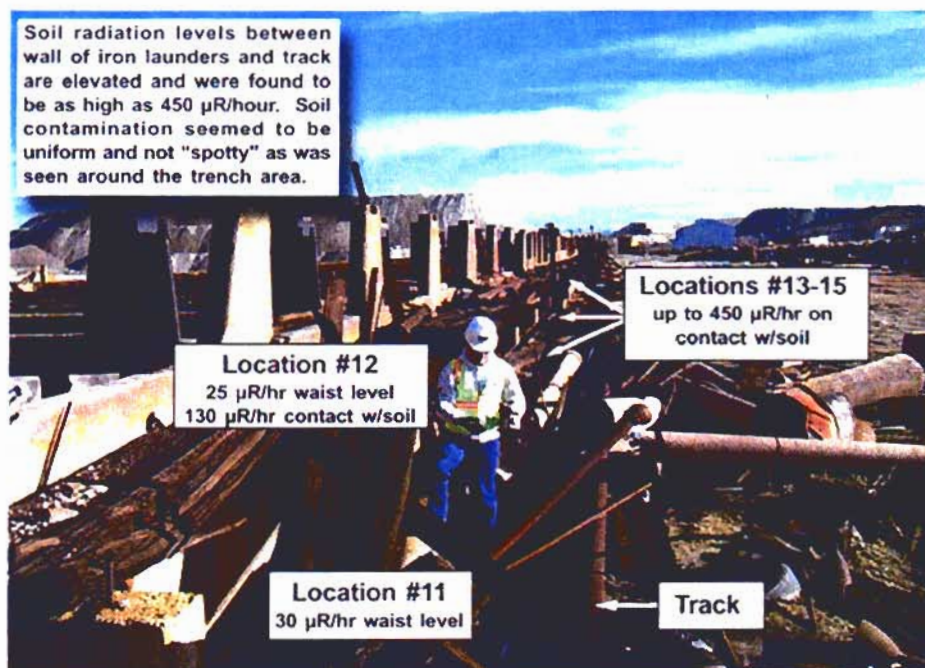


Figure 9 Survey Locations 11-15 Adjacent to the Iron Launders and Rail Tracks.

A final set of surveys was performed around the solution tanks and middle walkway, leading to the upper vat tank area. As shown in **Figure 10**, location 16 was a measurement taken on the roadway between the solution tanks and the iron launders. The radiation exposure rate increased as the detector was moved closer and then over the edge of the solution tanks.

Location 17 consisted of two measurements. The first measurement was taken on the outside portion of the solution tank wall near the ground surface, while the second measurement was taken on the inside portion of the wall, while extending the instrument down in the tank as far as the surveyor could reach. As shown in **Figure 10**, the residual sludge still remaining in the tank has a characteristic red color as identified for other locations in the process area where elevated radiation levels were observed.

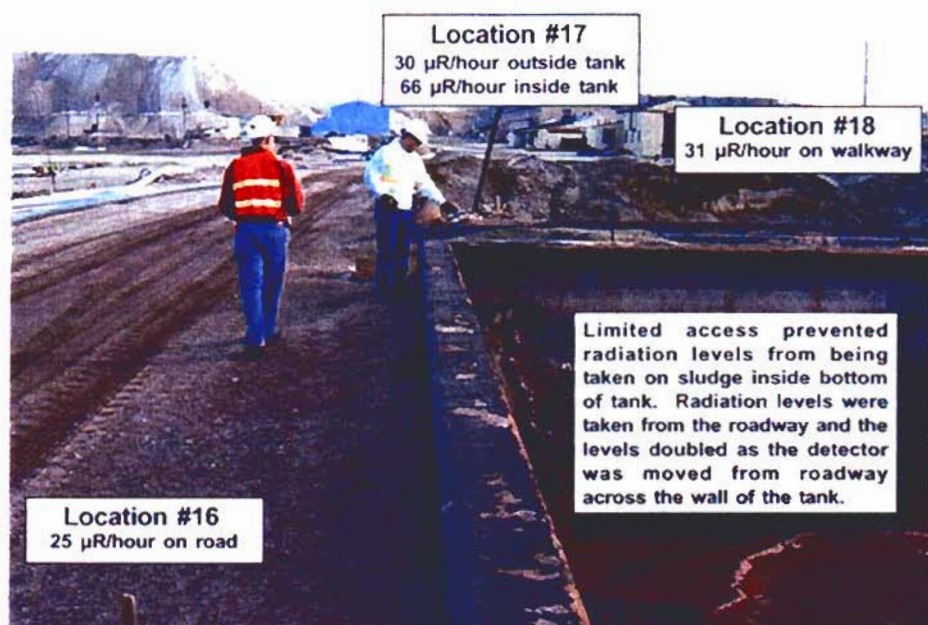


Figure 10 Survey Locations 16-18 and Radiation Levels Recorded Around the Solution Tanks.

Measurement locations 19, 20, and 23 were located at the upper edge of the walkway between the solution tanks, near the wooden bridge and stairs. As shown in **Figures 11 and 12**, elevated radiation levels were identified in this area. The measured radiation exposure rate ranged from 40 $\mu\text{R}/\text{h}$ at waist level for location 23 to the highest surface measurement of 5,700 $\mu\text{R}/\text{h}$ (5.7 mR/h) on contact with the surface at location 20.

The source of elevated radiation in location 20 consisted of heavy wood timber that appeared to be contaminated with the red colored material. This red like soil has the appearance of the sludge material in the bottom of the solution tanks and some surface soil areas around the process area and waste ponds.

Measurement locations 21 and 22 were not shown in the figures of this report, but the results are provided in **Table 2**. The measurement location 21 was located on the roadway near the upper vat tanks. The exposure rate measured 20 $\mu\text{R}/\text{h}$ at waist level in this area. Location 22 was an area of red colored soil located just above the solution tanks. The exposure rate measured 90 $\mu\text{R}/\text{h}$ on contact with the surface soil.



Figure 11 Measurement Locations 18 and 19 Located on Walkway Access Between the Solution Tanks.

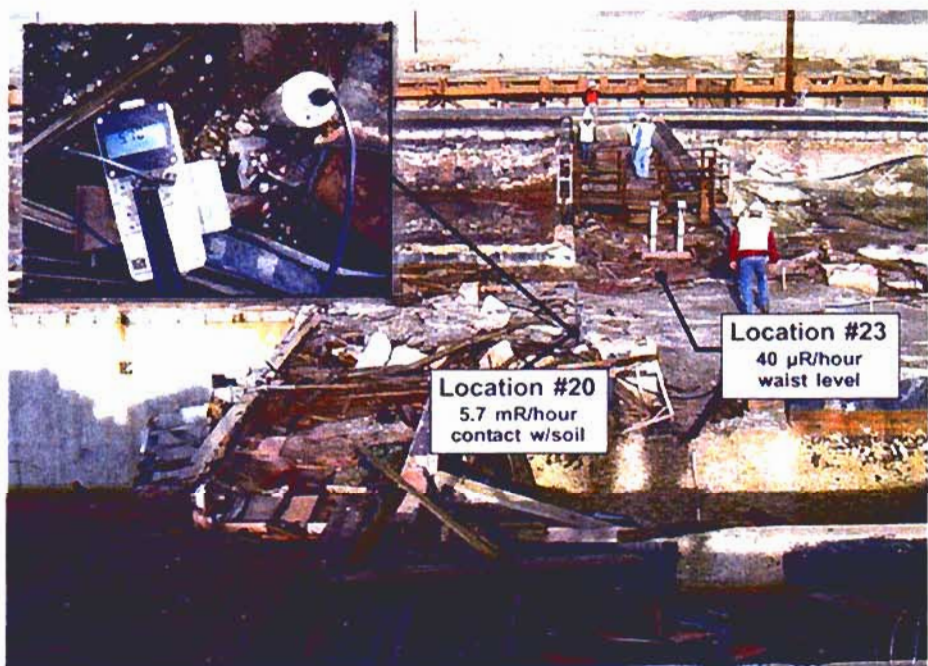


Figure 12 Measurement Locations 20 and 23 Located on Upper End of the Walkway Access Between the Solution Ponds. The Highest Measured Exposure Rate of 5,700 $\mu\text{R}/\text{h}$ (5.7 mR/h) was found on contact with debris and red-colored soil and is shown in the photo detail above.

Summary and Recommendations

Operations at the Yerington Mine appear to be in the preliminary to early stages of site characterization, particularly for evaluating the extent and magnitude of radiological contamination. Preliminary survey results presented in this report did not identify unacceptable, external radiation hazards for personnel working in the general area. However as observed during the site visit, there are several discrete soil areas, piping, trenches, and building debris where elevated concentrations of natural radioactivity were identified. These areas may warrant additional characterization to ensure that radiological controls are implemented to reduce the exposure risk to workers from direct contact with the radioactive materials located in these areas.

The characterization phase of the Yerington Mine process area should include a methodology for conducting direct radiation survey measurements to identify and assess the discrete locations of elevated radiation. These locations will not be isolated to surface soils, but will also include structural debris, piping, subsurface trenches, and tanks. As identified in this preliminary site visit and scoping survey, the majority of radiological contamination was identified as being in discrete or isolated locations in the process areas.

The subsurface structures, including the solution ponds, and many of the surface structures within process area were not accessible during this site visit. These areas warrant further investigation to determine not only the radiological exposure hazards to the workers, but also the extent and magnitude of contamination that may be located in these areas. Because the Yerington Mine has not been in use for some time, there is significant structural damage and a great deal of debris and rubble in the process area of the site. Most of the subsurface structures are open areas and do not have support railing along the surface to prevent someone from falling into one of the tanks or trenches. These areas pose a significant, if not larger, risk to the workers than the radiological hazards.

During the site visit, it was noted that overall radiological control aspects of the health and safety plan have not been fully implemented at this point. Specifically, a few concerns were identified to the primary contractor regarding proper use and control of personnel dosimetry. Thermoluminescent dosimeters (TLDs) are currently being stored without the proper control badges when not in use. Furthermore, it was observed that workers at the site had left their individually-assigned dosimeters on the safety vests that were provided to BLM visitors during the site visit. Ideally, a badge board for the storage of TLDs should be utilized. TLDs should be stored on the badge board when not in use and a control badge should also be placed on the badge board. The badge board should be located in a low radiation dose area away from areas where radioactive materials are used, handled, or stored. This observation was reported to the ARC site operations manager for corrective actions.

Until such time that the processing area and waste streams have been fully characterized and the appropriate radiological controls have been established, the site contractor should be encouraged to establish a formal location within the controlled area for conducting radiological contamination surveys of personnel and equipment prior to allowing them to leave the controlled areas of the site. The administrative building area would be an ideal location since it serves as a central point for controlling access and egress to the site. Having a formal survey station established is especially important since private contractors will likely be moving personnel and equipment in and out of the process area of the site where the majority of soil contamination has been identified. There should also be an established area near the survey area where equipment and personnel decontamination can take place. This area should have both hot and cold running water since personnel decontamination is best accomplished using mild soap and luke warm water. Of particular concern is the fact that there did not appear to be running water at the administrative building. The lack of running water will impact the ability to perform both personnel and equipment decontamination.

A fair amount of radiation survey and soil sampling data has been collected by multiple agencies. To date, it is not clear as to whether a reference background location has been selected and sampled for comparing measurements and samples collected at the Yerington Mine site. Because the contaminants (radionuclides) are also found naturally in the environment, a background data set should be established for comparison to results collected at the mine site.

During the site visit, several soil contamination areas were identified through elevated radiation measurements. Soil samples were obtained from two locations within the process area. These samples were submitted to a radioanalytical laboratory for specific analysis of uranium, thorium, and radium concentrations in contaminated soils. Combined with previous soil sampling efforts at the site, the soil concentration data should provide useful information about the relative radionuclide contributions associated with the elevated radiation measurements. Also, the soil concentration data for individual radionuclides can be utilized to further assess the potential exposure to workers from inhalation hazards that may occur when contaminated soils are disturbed. Result for the soil samples collected during the site visit should be available in late January of 2005.

References

Foxfire Scientific Inc.,2004, *Yerington Mine Site Worker Radiological Dose Assessment*, February 26, 2004.